A CLOSER LOOK

…at Everglades Research

Research provides the foundation for understanding and preserving the Everglades ecosystem.

The Everglades is a collage of unique plants and animals

The Everglades landscape is a unique collage of subtropical wetlands and uplands, including sawgrass marshes, sloughs, marl- and peat-based wet prairies, tree islands, tropical hardwood hammocks, pinelands, and at its southern most extreme, mangroves and the Florida Bay estuary. The wildlife of the Everglades is both diverse and unusual, and includes creatures such as alligators, snail kites, apple snails, woodstorks, white tailed deer, and panthers.

The original Everglades extended south from Lake Okeechobee to the peninsular tip of Florida, east to the coastal ridge (with occasional connections to the sea through areas known as the transverse glades), and west to the Immokalee Ridge (roughly the border of the Big Cypress National Preserve). A large portion (more than 700,000 acres) of the original Everglades that lay immediately south of Lake Okeechobee has now been converted to the Everglades Agricultural Area. Additional areas along the eastern border of the Everglades are now urban areas. In total, about half of the original 2.9 million acres of Everglades wetlands has been transformed for human uses, and three major wetland types (custard apple swamps, short-hydroperiod wet prairies, and cypress strands) have been severely reduced in size.

In review…

- Determine phosphorus concentrations that protect and restore the Everglades.
- Define mechanisms and quantify rates of nutrient cycling and retention by Everglades soil and water.
- Identify water depths and duration that are optimal for aquatic food webs, including wading birds.
- Develop models for predicting nutrient fate and transport, and vegetation responses to changes in hydrology and nutrient loads.

The Everglades that remain today have been significantly affected by construction of the Central and Southern Florida project, which includes 1,400 miles of canals that were dredged through the wetlands. Operation of the project for flood control and water supply purposes has caused some areas to become drier and other areas to become wetter than normal. This and the loss of short-hydroperiod wet prairies to urban areas have adversely impacted food webs that support wading bird populations. The project also has conveyed nutrient runoff from the Everglades Agricultural Area to natural areas, where undesirable shifts of vegetation communities have occurred. Changes in hydrology altered the extent of naturally occurring fires, and provided areas suitable for successful invasion of exotic (non-native) species such as melaleuca, Australian pine, and Brazilian pepper. Hydrologic changes also have impacted downstream estuarine systems that no longer receive historical quantities and timing of overland water flow.

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Undesirable changes to the Everglades resulted in a number of lawsuits that led to settlement agreements and legislation for enhancing and protecting the remaining Everglades. A requirement of the Everglades Forever Act legislation was that research, monitoring, and modeling should be conducted to guide future management water quality and quantity decisions affecting the Everglades.

District researchers measure photosynthesis and transpiration of Everglades plants. Hydrologic and nutrient conditions have been found to affect the dynamics and community structure of Everglades vegetation.

Research helps understand and predict ecological changes

Everglades research focuses on understanding and predicting ecological changes in the Everglades as a function of natural and human causes. Experimental studies conducted in field and greenhouse settings are one of the best ways to determine cause and effect relationships. Two major efforts are under way: determination of nutrient concentrations and loads that will prevent an imbalance of native Everglades flora or fauna; and determination of how hydrology (water depth, flow, and duration) affects plant communities, nutrient cycling, food webs, and wading birds. Modeling efforts seek to predict and understand long term change. The South Florida Water Quality Model was developed to predict nutrient fate and transport, and the Everglades Landscape Model was developed to predict landscape vegetation changes in response to changes in hydrology and nutrient loads. Finally, a vegetation mapping effort is documenting changes occurring from natural or human activities, including the restoration projects themselves.

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Nutrient concentrations that prevent imbalance

The Everglades evolved under very low nutrient conditions, with rainfall and overland

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water flow as its primary source of phosphorus. Restoration efforts call for determination of nutrient levels that will not cause an imbalance of native Everglades flora or fauna. The District's extensively peer-reviewed monitoring and research program to do so is being conducted in all three Water Conservation Areas. In addition, carefully controlled and replicated greenhouse studies of nutrient and hydrologic effects on Everglades vegetation communities are being conducted at the Everglades Botanical Research Complex located on the campus of Florida Atlantic University.

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Biological and chemical monitoring in the Water Conservation Areas is conducted along transects that start at inflow structures where nutrient concentrations are high and end deep in the marsh interior where nutrient concentrations are low. At locations with high phosphorus concentrations, native vegetation (sawgrass and spike rush sloughs) has given way to undesirable vegetation (cattail). Where phosphorus concentrations have remained low, native vegetation dominates. The phosphorus concentrations in these native vegetation areas most likely will be used to estimate "no imbalance" phosphorus levels. However, vegetation changes along the transect may result from factors other than phosphorus. Therefore, researchers are separating the effects of phosphorus from the effects of other factors through use of field chamber experiments. These chambers enclose representative sections of Everglades wetland and are injected weekly with various amounts of phosphorus. Clear differences in vegetation responses to phosphorus dosing alone have been documented by District researchers, confirming that certain changes measured along the transects resulted from phosphorus.

Hydrologic conditions are important for vegetation and food webs

Research is being conducted to determine optimal conditions for desirable Everglades vegetation and food webs that support wading birds. Greenhouse studies are being conducted to quantify rates of seed germination, seedling growth, and competition among vegetation, such as cattail and sawgrass, under varying hydrologic and nutrient conditions. Studies have shown that cattail, which has grown to nuisance proportions in the Everglades, out-competes sawgrass under conditions of elevated nutrients and increased flooding. Therefore, restoration efforts will need to reduce nutrient loading and return to more natural hydroperiods (water depth, timing, and duration). Wading bird foraging studies are being conducted in 0.5-acre ponds where water levels and fish abundance can be manipulated experimentally. Results show that optimal water depths and prey abundance conditions can be identified for wading birds in general, and for individual species as well. This information will be helpful in operating the Central and Southern Florida project

PARTNERSHIPS IN RESEARCH

- Harbor Branch Oceanographic Institute
- Florida Atlantic University
- University of Florida (IFAS)
- U.S. Army Corps of Engineers Waterways Experiment Station
- St. Johns River Water Management District

for optimal food web development.

Computer models predict effects of management actions

Computer models integrate research findings from separate disciplinary fields (e.g., hydrology, nutrient cycling, ecological responses) to provide a predictive, and comprehensive, decision-making tool for managers. Because Everglades water quality and ecological responses are directly affected by water quantity decisions, these integrative models must be consulted to clearly understand the full ramifications of management decisions. A distinct advantage of models is their ability to screen a large number of management alternatives that could not possibly be tested with the real system.

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The South Florida Water Quality Model is used to predict nutrient fate and transport through the Everglades. This model will be used to determine if nutrient concentrations needed to prevent an imbalance of Everglades flora or fauna will be met under a variety of hydrologic and nutrient loading conditions. The Everglades Landscape Model is an even more comprehensive model developed to understand and predict long-term landscape vegetation changes, including exotic species, that could result from fire, water, and nutrient management scenarios. Each model will used to determine the long-term effects of possible management scenarios, and will assist the District and other agencies in evaluating tradeoffs among water quantity, quality, and ecological objectives for the Everglades.

Mapping efforts document change

A multi-agency program to map Everglades vegetation is used to detect changes that occur from natural phenomena and human activities. These maps help assess the effects of nutrient and hydropattern restoration efforts on the spread of cattail and other invasive species throughout the Everglades. Remote sensing and digital image processing techniques were used to reconstruct the history of vegetation coverage in Water Conservation Area 2A for the period 1973 to 1991. Maps of Water Conservation Area 2A cattail acreage also have been made for 1991 and 1995 using photo-interpretation techniques and color infrared aerial photography. These maps show that the area of undesirable cattails expanded significantly during this period. Maps of the other Water Conservation Areas and Everglades National Park also are being constructed by a multi-agency group using photo-interpretation techniques and color infrared aerial photography.

Optimal foraging depths differ among wading birds, and are quantified in experimental ponds. Knowledge of optimal depths will help guide hydrologic restoration efforts.

What's ahead…

- Continued research and demonstration projects for supplemental technologies
- Refined estimates of water depths and duration for optimal Everglades functioning
- Determination of the importance of periphyton communities as a food source for higher trophic levels
- Use of stable isotopes to understand the origin and fate of materials in the Everglades
- Refinement of hydrology, nutrient fate and transport, and ecological models for predicting effects of management actions

For more information on Everglades Research, please contact the SFWMD at (561) 686-8800

For news on other SFWMD research projects, please see the following *Closer Look* publications:

- An Overview of Current SFWMD Research
- Estuary Research
- Kissimmee River Research
- Lake Okeechobee Research
- Southern Everglades and Florida Bay Research
- Stormwater Treatment and Supplemental Technology Research